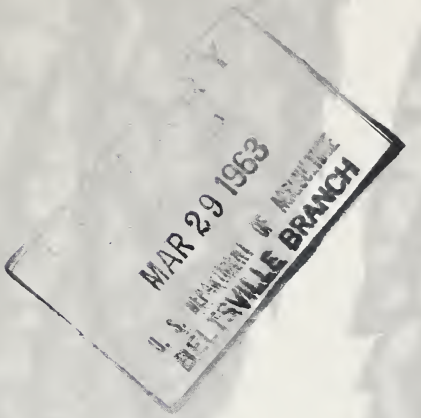
Agriculture
Information
Bulletin
No. 212



MINT FARMING

AGRICULTURAL RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE in cooperation with the
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

CONTENTS

PRECAUTION

Most chemicals used to control diseases and insects are poisonous. Handle them carefully. Follow all directions and heed all precautions on the labels. Store chemicals in closed containers in a dry place where children and animals cannot reach them.

Washington, D.C. Revised February 1963

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents

MINT FARMING

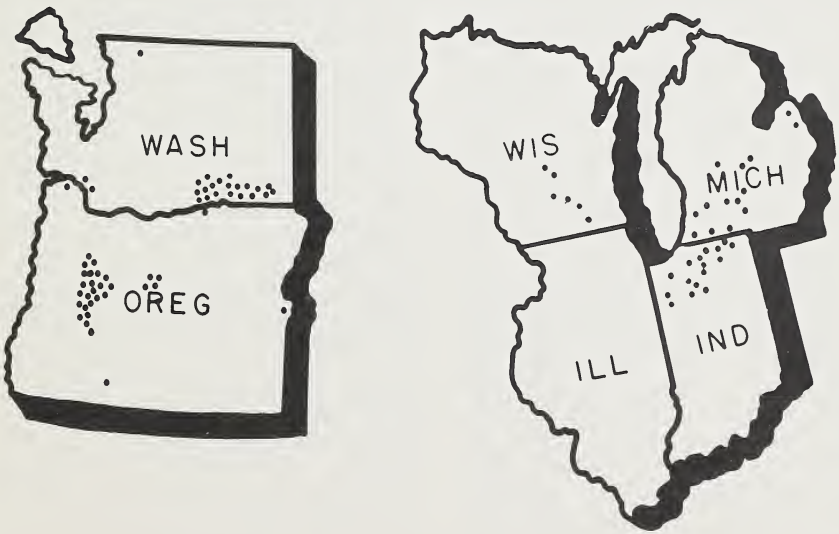
By Ralph J. Green, Jr., *collaborator, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and associate professor of plant pathology, Purdue University Agricultural Experiment Station*[1]

Most of the world's supply of peppermint and spearmint oils comes from mint grown in Indiana, Michigan, Oregon, Washington, and Wisconsin. Oil is the principal product of the mint crop, although fresh and dried mint leaves are used in the preparation of foods and beverages.

As mint oil is used in only a few products, the market for peppermint and spearmint oils will continue to be steady, although not in great demand. Peppermint oil is used to flavor chewing gum, candy, toothpaste, and medicine, in which the oil masks unpleasant flavors and odors. Spearmint oil has a smaller market and is used mostly to flavor chewing gum and toothpaste.

Mint grows best on muck and fertile sandy loam soils. Soils are especially favorable for this crop in Indiana, Michigan, Oregon, Washington, and Wisconsin (fig. 1). The total acreage of mint

[1] Acknowledgment is made to members of the State agricultural experiment stations in Indiana, Oregon, Michigan, and Washington for their assistance and cooperation in the preparation of this bulletin.



BN-8503

Figure 1.—Principal mint-producing areas of the United States in 1961.

TABLE 1.—*Acreage of mint and yield of mint oils in the United States* [1]

Mint and State	Area in production			Yield of oil per acre		
	Average, 1950–59	1960	1961	Average, 1950–59	1960	1961
Peppermint	*Acres*	*Acres*	*Acres*	*Pounds*	*Pounds*	*Pounds*
Indiana	9, 650	4, 600	5, 200	31	35	36
Michigan	7, 270	2, 000	1, 900	21	25	27
Wisconsin	2, 910	4, 500	4, 700	37	40	42
Washington	9, 550	13, 800	16, 000	70	75	79
Oregon	14, 170	14, 300	15, 300	52	57	63
Total	43, 550	39, 200	43, 100			
Spearmint						
Indiana	7, 340	6, 900	7, 800	34	34	36
Michigan	5, 790	4, 800	4, 700	29	28	24
Washington	2, 650	9, 500	12, 000	92	78	98
Total	15, 780	21, 200	24, 500			

[1] Source: Crops Reporting Board, Agricultural Marketing Service, U.S. Department of Agriculture, December 1961.

grown in the United States is about 43,000 acres of peppermint and 24,000 acres of spearmint (table 1).

Mint is susceptible to unfavorable weather and to insect and disease damage. As a result, oil yield per acre varies considerably from year to year. Nevertheless, mint culture can bring fair returns.

An important feature of mint farming is the removal of oil from the hay by steam distillation. Special equipment is needed for this processing operation, which is done on the farm.

The relatively large investment in distilling equipment, which generally cannot be used for other farm operations, places this short-term process at a disadvantage. Mint must compete with other intensive crops for the use of fertile and valuable land. These restrictions define the farmers' scale of operations. Unless they can use a neighbor's distilling equipment, small operators are at a disadvantage.

Before undertaking mint culture, farmers should consider carefully the suitability of their soil, the climate, and the cost of labor.

A midsummer day length of at least 15 hours is essential for satisfactory oil yields. Generally this requirement limits commercial mint production to areas north of the 40th parallel. Also, if the local area is sunny, with low rainfall at harvesttime, yields of mint oil are much higher.

Prospective mint farmers should make a careful study of the cost of erecting a still, especially in a locality where there are no other mint producers with whom arrangements can be made for distillation. Also, farmers should consider the availability of labor to plant and weed the crop, to harvest the mint, and to distill the oil.

MINT-PRODUCING AREAS

Large areas of muck soil in Michigan and Indiana were found to be so well adapted to mint culture that this region was the center of mint production until about 1940. At this time the acreage in Michigan began to decline as a result of crop losses caused by Verticillium wilt. More recently, the same disease has caused crop losses and reduced mint acreage in Indiana.

Establishment of mint on newly cleared muck soils in southern Wisconsin occurred later than in Michigan and Indiana. Less than 100 acres in Ohio are all that remain of mint plantings in the Eastern United States.

Success in peppermint culture in the muck soils of the Midwest led to experimental plantings in the Northwest, where soils are similar. The crop is now firmly established in Washington in the irrigated districts of the Yakima Valley from Yakima east to the Kennewick area. It is also produced on both sides of the Columbia River and in Oregon along the Willamette River and on the islands west from Portland, as well as in Jackson, Jefferson, and Malheur Counties.

Spearmint is grown commercially in Michigan, Indiana, and Washington but on a much smaller acreage than peppermint.

DESCRIPTION AND TYPES OF MINT

The mints are perennial plants with square stems. They bear oil in glands, mostly on the undersurface of the leaves. The plants bloom profusely, but the commercial varieties rarely set seed. Mints reproduce readily by means of runners, called stolons. The stolons grow under and on the surface of the soil and spread out in all directions. They take root and send up new growth at the nodes or joints. To start a new field, sections of the stolons or of the new shoots are planted.

Mint plants grow to a height of 3 feet, and even higher if the soil is rich and the plants are crowded. When the plants are grown in rows or kept sufficiently thinned out, they develop numerous branches and become bushy.

Peppermint (*Mentha piperita*) varieties grown commercially in the United States are the black and American. Because of higher yields, black peppermint is grown more extensively. Black peppermint is also known as black mint, English peppermint, and Mitcham mint. It has dark-purple stems and deep-green, broadly lanced, and slightly toothed leaves. The light-purple flowers are produced at the end of the stems (fig. 2).

American peppermint (known also as American mint and State mint) is very hardy, but it yields less oil than the black mint and therefore is not recommended for commercial production. Common spearmint (*Mentha spicata*) and Scotch spearmint (*M. cardiaca*) look like the peppermint plant, but Scotch mint is hairier and its flowers grow in whorls at points where the leaves join the stems. Scotch mint has largely replaced common spearmint in commercial plantings, because the Scotch mint has greater vigor and productiveness (fig. 3).

Wild mint grows in many parts of the United States. Some varieties contain oil, but it is a poor quality and has no commercial value. However, if peppermint or spearmint is to be planted on land where wild mint occurs, the native mint must first be thoroughly erad-

BN—8514—N

FIGURE 2.—Peppermint, showing characteristic leaves and flowers

BN-8516-X

FIGURE 3.—Spearmint, showing typical flowers and leaves: Left, Scotch mint; right, common mint.

icated. Native mints will cross with commercial varieties or crowd out the cultivated plants, and thus lower the quality of the oil.

Japanese mint (*Mentha arvensis* var. *piperascens*), a rich source of menthol, is very different from peppermint and spearmint. This plant is often erroneously called "Japanese peppermint," but it should not be confused with true peppermint. The Federal Food, Drug, and Cosmetic Act requires that products containing Japanese mint oil be labeled "flavored with corn mint" or "flavored with field mint." Only a limited amount of Japanese mint is grown in the United States, although large amounts are grown in Japan and Brazil.

CULTURE

Mint spreads vigorously, owing to the lateral growth of stolons and sprouting of plants from its stolons. In the Midwest it is usually planted as a row crop and then allowed to spread over the field into a solid stand in subsequent years. This solid stand, called meadow mint, contributes to the spread of both weeds and diseases. After the mint has spread beyond the planted rows, weeds, particularly perennial grasses, are difficult to destroy. Although meadow mint may be kept for several years, yields may decrease and weeds and diseases increase as the stand becomes older.

In the irrigated areas of the West, mint is grown only as a row crop. The same field may remain in mint for several years, but each fall the old planting is plowed shallowly and the rows are defined in the spring. Or, the original mint row is removed in the spring with a potato digger, the field leveled by harrowing, and the new row then becomes what was the center between the old rows the year before.

When a mint stand is abandoned, the field is planted in the spring to a crop that can be cross-cultivated to eradicate both weeds and mint. Corn is often grown, as it is difficult to eradicate mint from such row crops as carrots and onions.

Soil Requirements

Mints do best on deep, rich soil that has fairly loose texture and permits easy root penetration. An abundance of humus is desirable. The soil should range from mildly acid to neutral or barely alkaline. The preferred pH range is from 6.0 to 7.5. A very acid soil may require liming before it can be used. The soil should be well drained but a type that does not become too dry. Land that contains a large proportion of clay is usually unsatisfactory.

Suitable growing conditions are most readily available in the well-drained muck soils used for celery, onions, cabbage, and similar crops that require quickly available soil elements to produce strong and rapid growth. As a rule, drained muck soils also offer another advantage—the possibility of controlling the water level by the use of gates in the drainage ditches. Where possible, the water table should be held at about 2 feet from the surface; just prior to cutting time, it is advisable to lower the water table to 30 to 36 inches. Deep fertile upland soils of sandy or gravelly loam texture that will produce potatoes and corn are also reasonably suitable for mint culture.

Next in desirability for mint culture are the sandy loam soils of the

Pacific Northwest. These soils are found on the low tablelands that lie adjacent to the Willamette River bottom land in Oregon and in the irrigated districts of the Yakima Valley in Washington. Like the muck soils, the Willamette Valley soils are drained by ditches and, being subject to spring overflows, are also protected from the river in most cases by dikes. With good cultural practices, the sandy loam soils are well adapted to mint production.

Level stretches of muck land in Michigan and Indiana, while ideal as to soil, are subject to severe winds of several days' duration in the spring. When such winds follow a prolonged drought, the soil blows and it may severely damage the tender plants. In such situations, windbreaks are planted, usually of willow, in north-south rows, with an occasional east-west row (fig. 4). Stripcropping in the field at intervals with rye also affords some protection for first-year mint.

BN—8513—X

FIGURE 4.—Willow windbreaks in a harvested mint field in northern Indiana.

Soil Preparation

Weed infestation is a serious problem in mint. The year before the mint is planted, the land should be planted to a clean-tilled crop or should be plowed and left fallow. In either event, the soil is worked as long as possible before planting, to reduce the weeds that cause a great deal of trouble in the mint field. If plowing is deferred until spring, it should be done as soon as the soil is dry enough for field work. In Midwest muck soils, the field may be plowed in the fall, after clean tillage of the preceding crop, if that is more convenient. However, the mint-growing districts of the West that are subject to winter and spring flooding should not be fall-plowed, as soil washing may result.

After plowing, the field is disked and thoroughly harrowed. If the soil is loose and dry, the field is rolled frequently to firm it. If the field is fall-plowed, disking it in both directions at planting time may be necessary to get it into the best condition.

Propagation and Planting

New mint fields are generally started by stolons, although sometimes young plants are used. A field previously selected for the purpose—usually one that was planted during the preceding spring—supplies the stolons for planting. Farmers, who are getting their start as mint growers by buying stolons from established fields in the same locality, usually dig and haul the stolons from a designated area.

If stolons are obtained from a distant locality, the grower packs them in grain sacks and ships them with as little delay as possible. Usually new growers purchase only sufficient planting stock for a few acres and enlarge their plantings from their own stock in subsequent years at comparatively little cost.

The quantity of stolons required to plant an acre depends on the spacing in the furrows and the dis-

tance between rows. An acre of well-established mint in which there has been no winter damage will frequently yield enough stock to plant 20 acres, but on the average an acre produces only enough stolons to plant 10 to 15 acres. About 20 sacks of stolons, as packed for shipping, are required to plant an acre.

Growers either plow out stolons for planting stock or dig them with a potato digger and then shake the stolons free of loose soil with pitchforks. The stolons are deposited in piles that are not too large or they will heat and spoil. The vitality of the stolons is easily reduced if they are permitted to wilt through exposure to sun or wind. The approved practice is to cover the piles with soil or other material, if the stolons are not to be planted immediately.

To give the crop a good start, the stolons are planted as early as conditions warrant. In the West, growers usually begin early in March, but in Indiana and Michigan growers wait until April or May, as the muck soils are generally not in workable condition earlier. The ground should be reasonably warm and not too wet. Prolonged cold and wet weather frequently causes the planting stock to rot. However, warm weather sometimes forces early growth, after which a late spring frost may do much damage. Although the late frost does not kill the stolons, it depletes their strength and frequently prevents a full crop from developing.

Stolons should not be planted in a very dry soil. Furrows should not be laid off faster than the planting proceeds; thus, the stolons can be laid in the damp soil of a newly turned furrow and covered immediately.

If new fields are to be started with young plants, transplanting should wait for the arrival of permanent warm weather. The plants will be about 4 or 5 inches high and can be readily pulled out of the ground, especially out of muck soil. The young plants will have a small cluster of roots at the base of the stem.

The use of young plants instead of stolons for starting a mint field has certain advantages. Late planting avoids the cold weather that frequently retards or even destroys young growth from stolons. Transplants, therefore, serve as insurance against crop loss.

Also, in certain areas of the Willamette Valley, Oreg., stolons are planted in the fall rather than spring. This reduces weed problems and avoids the unfavorable weather often encountered in the spring.

Attempts to mechanize the planting of stolons have not been entirely satisfactory. A mechanical planter requires more stolons per acre than hand planting and stands are frequently uneven. Some growers have used mechanical planters with success and their use may increase. For hand planting the work schedule should be planned so that hand labor is available for mint planting when other work is less demanding. In the Midwest, this labor is available before planting other crops, as mint stolons are more tolerant of inclement weather and poorly prepared seedbeds than seeded crops.

When planting stolons by hand, workmen lay off 4- to 6-inch furrows about 3 feet apart; these furrows are made just ahead of the setter, so the furrows remain moist until planting is completed. When setting the stock, the planter hangs a sack of stolons from his shoulder by a strap. He drops the stolons lengthwise and end to end into the furrow and, with one motion of the foot, covers the stolon and tamps it. Later, the soil may be firmed on the planted stolons with a rubber-tired roller or a leveler.

An experienced operator may

plant an acre a day; an inexperienced operator may do well to plant a half acre. If the soil is deep and loose or if the operator has to select the plants or stolons because of the poor quality of planting stock, his rate of setting may be slowed down.

Mint transplants are usually set by machine. An implement similar to those for transplanting tomatoes and cabbage opens a furrow, sets the plants, and covers them in one continuous operation. Usually two operators per row are needed for these single- or multiple-row machines. The operators alternate in placing transplants in the planter just ahead of the setting operation.

Weed Control

Lambsquarter, nettles, pigweed, ragweed, smartweed, and marestail are common and objectionable weeds. Some weeds color the mint oil and others contain oils with pronounced odors and are particularly to be avoided.

Various grasses frequently cause considerable trouble in older mint fields. Although the oil may not be affected as unfavorably by the grasses as by the above-listed weeds, the grasses are difficult to eradicate, because most of them are perennials and spread rapidly by means of rootstocks.

Herbicides provide a simple way to control weeds in row mint. For Midwest muck soils the herbicide is sprayed on when the mint shoots begin to emerge. Only a half-coverage band needs to be sprayed over the rows and weeds between the rows can be eliminated with standard cultivation equipment until the stolons spread into the open spaces, when it is inadvisable to cultivate. The planting must be hand weeded to eliminate weeds that appear before harvest.

On the mineral soils of the Pacific Northwest, use of herbicides for weed and grass control is most effective if applications are made immediately after plowing and worked well into the soil.

For Midwest muck soils, a combination of 9 pounds DNBP (4,6 dinitro ortho secondary butylphenol) and 6 pounds of CIPC (isopropyl N-3-chlorophenyl) per acre gives good weed control for several weeks following application to row mint.[2] In the West, diuron [3-(3,4 dichlorophenyl)-1,1 dimethyl urea] is used at rates of 3 pounds per acre on heavier soils and 2 pounds on light sandy soils to control weeds in meadow mint.

Growers should consult the State agricultural experiment station or the county agent for specific recommendations of herbicides in a given location. It is extremely important that attention be given to the rates and methods of application of these chemicals for the most satisfactory control of weed pests.

Fine-toothed harrows and rotary hoes are still used extensively for weed control. These implements do little damage to mint plants up to 5 to 6 inches in height. The soil should not be cultivated when chemicals are applied for weed control, as working the soil reduces the chemicals' effectiveness.

Cultivations cannot be continued long enough to control the weeds unless the field was kept clean the preceding year. Usually, hand weeding is necessary, and weeding crews are sent through the fields several times during the summer to remove the weeds, especially those that would reduce oil quality.

To keep down the weeds in second-year or older plantings, geese and sheep are sometimes used in western Oregon. They will not

[2] Mention of specific products does not imply recommendation by the U.S. Department of Agriculture over similar products not mentioned.

FIGURE 5.—Three-section rubber-toothed harrow used for cultivating mint in the Midwest.

bother the mint unless other plants are scarce or the mint is small. One disadvantage of geese is their reluctance to consume anything but the youngest weeds. Lambs and yearlings are preferred to older animals, because sheep that are kept on the fields for several years become accustomed to the mint and may eat a considerable quantity. One sheep per acre is usually adequate.

Second-year and older fields are worked with cultivators or harrows as early in the spring as possible. In the Midwest, rubber-toothed harrows are used to eliminate weeds and loosen the soil (fig. 5). Fields may be worked several times in both directions. If stolons are abundant and the stand is dense, these cultivations may be continued to help thin the stand and retard heavy growth. Thinning is beneficial; it produces bushier plants with larger leaves.

After the mint crop is harvested, the fields need no further attention until late in the fall, unless some fertilizer is added. Shortly before frost, mint grown on muck soils in the Midwest is plowed to a depth of 4 to 6 inches to protect it from winterkill. In the Pacific Northwest, fall plowing is recommended only on lands that do not wash during heavy winter rains or spring overflow.

Fertilizers

Commercial fertilizers are used by mint growers in all areas and usually increase yield of oil where the soil is not fertile. In most cases, fertilizer applications do not affect the quality of the oil except by affecting the maturity of the plants. The kind of fertilizer and the rate of application depend on the type of soil, preceding crop, and management practices in the particular locality.

On the highly organic muck soils of the Midwest, 300 to 500 pounds of 5–20–20 fertilizer, or its equivalent, is applied to first-year mint. In cool, wet seasons, 25 to 50 pounds of nitrogen per acre is applied as a side dress to give young plants a better start. Unless the soil is im-

poverished, higher rates of application are not generally recommended. The fertilizer may all be broadcast before planting, or part may be applied in the row but not in contact with the stolons.

On established plantings, 250 to 500 pounds per acre of 5–20–20 fertilizer or equivalent is applied broadcast and harrowed in before growth starts in the spring. Additions of nitrogen may also be made to improve spring growth. Response of meadow mint may be erratic, however.

On the sandy loam soils of eastern Washington and Oregon, where mint is grown under irrigation, the equivalent of 120 pounds of nitrogen per acre is applied, usually as ammonium sulfate or ammonium nitrate. Potash and phosphorus are not used unless soil analysis indicates a need for one or both elements.

On the mineral soils of the Pacific Northwest, manure is used alone or in combination with commercial fertilizers. Only well-rotted manure should be used so that weeds will not increase. Manure is not used on muck soils, as it may reduce the yield of mint in dry seasons.

Minor fertilizer elements are seldom added. Mint grown on neutral or alkaline muck sometimes responds to soil or leaf applications of manganese and the addition of copper is sometimes beneficial when the soil pH is 5.5 or lower. Applications of boron may be helpful in certain areas of Oregon and Washington.

Irrigation

Mint requires considerable water throughout the growing season. This makes it necessary to irrigate in most of the regions in which the crop is grown. In south-central Washington and eastern Oregon, where there is little summer rainfall, the crop requires 50 to 60 inches of water.

Beginning early in May, mint is irrigated by furrow at intervals of 1 to 2 weeks, as necessary. In first-year mint, a single furrow is made between the rows. For meadow mint, implements designed for the purpose dig shallow ditches or rills about 30 inches apart. Often, the irrigation ditches are dug where the mint row was originally planted.

In some localities in western Washington, in the Willamette Valley in Oregon, and in many places in the Midwest, sprinklers are used to irrigate the crop. In the West, the crop is irrigated one to five times during the season according to need. In addition to supplying supplemental water during periods of drought in the Midwest, sprinkler systems are used to reduce damage from frost and to prevent injury from windblown soil early in spring.

To subirrigate muck soils that have been ditch drained, the water level is raised by closing the ditch gates.

DISEASES AND NEMATODES

Verticillium wilt and mint rust are two serious diseases that attack peppermint and spearmint; mint anthracnose, or leopard spot, may damage peppermint in some seasons. Certain other leaf and stem diseases may be troublesome. Three species of nematodes attack the peppermint crop in Oregon and Washington.

Verticillium Wilt

Verticillium wilt (caused by *Verticillium albo-atrum*) is the limiting factor in peppermint production in the older mint-producing areas of the Midwest. In Indiana and Michigan large acreages of otherwise suitable peppermint land are no longer planted to this crop because of wilt. This disease is less destructive to common and Scotch spearmint. Since 1954, wilt has increased rapidly in certain areas of the Pacific Northwest and has been found in limited areas in Wisconsin.

Evidence of mint wilt may appear in the field as early as April or May. Affected plants are dwarfed and show uneven growth; the foliage is a bronze color and rapidly turns yellow and the plant dies. Plants that develop symptoms later in the season exhibit considerable twisting and curling of the upper leaves (fig. 6, *C*) and are also somewhat stunted. The foliage lacks good color and the plants may wilt. Infected plants become progressively yellow, beginning with the lower leaves, and then turn brown and die.

Mint wilt usually begins in the field on isolated plants or in small spots. The disease spreads in the second year and on subsequent crops and it is most destructive in older mint plantings. Wilt-infested fields usually give poor stands of mint because good stolons do not develop and weed problems are increased.

The fungus causing this disease persists in the soil almost indefinitely after it becomes established in a field. It invades the mint plant through the roots and stolons and disrupts the water-conducting elements of the plant stem. After the plant dies, the fungus continues to live on the plant debris and is returned to the soil in this manner. The disease is spread within the field and from field to field on infected stolons used for replanting, on machinery and equipment, by windblown soil, or by any means in which soil or plant debris may be carried.

Crop rotation is of little value for disease control, because the fungus remains viable in the soil for many years. In Washington and Oregon, this disease is also prevalent in a number of other crops and, when mint is planted following potato, tomato, cane berries, strawberry, peach, cherry, plum, and certain nursery crops, wilt may appear in the mint planting.

Growers who are planning to start mint culture in new areas should obtain wilt-free planting stock. In addition, movement of machinery and equipment from infested fields to other fields or areas should be restricted to prevent introduction of the disease.

The most effective method to control Verticillium wilt would be the development of resistant types of mint. However, all varieties of peppermint and spearmint are susceptible, to some degree, to this disease and at present (1962) no wilt-resistant hybrids or varieties are available.

Growers in the Midwest have reduced the destructiveness of mint wilt by growing the crop only 2 years and by using planting stock from fields that are as free from the disease as possible. Because the acreage of this crop is comparatively small, growers continuously shift to new land, whenever possible. In Oregon and Washington the development of new lands for mint production and rigid inspection of planting stock is being utilized to limit the spread of this disease.

FIGURE 6.—Diseases of peppermint and spearmint. *A*, Mint anthracnose, or leopard spot, showing the gray-colored, sunken lesions on the stem and lower leaves; *B*, mint rust on spearmint leaves, showing the typical golden-brown spots produced in early summer; *C*, symptoms of Verticillium wilt on peppermint; note the severe stunting and wilting of the infected clone; *D*, mint rust on peppermint shoots showing the light-yellow, blisterlike lesions that occur in the early spring; *E*, symptoms of stolon decay that reduces the vigor of peppermint and spearmint planting stock.

Mint Rust

Mint rust (caused by *Puccinia menthae*) is a serious problem on peppermint in western Oregon and Washington and frequently causes severe losses on spearmint in Indiana and Michigan. Rust defoliates heavily infected plants before harvest.

The symptoms and effects of mint rust are similar on peppermint and

spearmint. However, rust on common spearmint will not infect peppermint, nor will the rust on peppermint infect common spearmint. But Scotch spearmint is susceptible to both races of the mint rust.

In the spring, mint rust first appears as light-yellow blisterlike spots on the stem and leafstalks of infected plants (fig. 6, *D*). The few infected plants are easily recognized because they are usually twisted or distorted and break off easily at the point of infection. From these stem lesions, the disease spreads rapidly during early summer to produce golden to cinnamon-brown spots on the leaves and stems of infected plants (fig. 6, *B*). When these leaf spots become numerous, the infected leaf curls, turns brown, and drops from the plant. Heavily infected plants may be almost completely defoliated.

In late summer and fall, leaf spots on the stubble and regrowth become dark chocolate brown. This is the overwintering stage of the rust fungus and is the source of new infections the following spring.

Clean plowing is the most important step in the control of mint rusts. The overwintering stage on the stubble, the regrowth, and the infected soil surface will be practically eliminated if these sources of infection are turned under cleanly in the fall. In addition, wild mints, volunteer plants, and weeds should be eliminated from field borders and ditches, to reduce the amount of infection that may be blown into the field later in the season.

In western Oregon and Washington, the use of DNBP for preemergent weed control is also effective for control of early season peppermint rust infection. The mint stubble is plowed and the field worked well before treatment. Cultivation should be delayed as long as possible after treatment, as the effectiveness of the chemical is reduced if the soil is disturbed.

Propane gas burners have been used to good advantage to reduce early season rust infection in Oregon and Washington. Mint stands are treated when the shoots are emerging and special equipment involving a shielded burner is needed. The purpose of this treatment is to eliminate the early rust infections by destroying the first mint shoots. It does not reduce subsequent growth of the stand and often is beneficial to the stand.

Spearmint rust occurs sporadically in the Midwest but may be destructive. Local outbreaks often occur when clean plowing is neglected or growers do not plow deep enough to cover all crop debris.

Mint rust may become severe later in the growing season if climatic conditions are favorable for disease development. Prompt application of recommended spray chemicals usually checks the disease. Dusting or spraying should begin before the rust becomes prevalent and continue at 7- to 10-day intervals until 2 to 3 weeks before harvest. The foliage should be covered thoroughly with the dust or spray for good rust control.

Mint Anthracnose

Mint anthracnose, or leopard spot (caused by the fungus *Sphaceloma menthae*), is occasionally destructive to peppermint, especially in Indiana. The first symptoms of the disease appear on the lower stem and stolons as small, sunken, brown spots. These enlarge to form oval lesions with light-gray centers and reddish-brown borders. Often the spots unite to form large cankers that cause the stem to split (fig. 6, *A*). Similar brown spots appear on the lower leaves. These gradu-

ally develop light-brown centers with a dark border. The centers of these spots often drop out. Heavily infected plants are weakened and oil yields are reduced. Such plants frequently do not survive the winter.

Anthracnose is most severe during wet seasons when the mint foliage becomes rank and remains wet for long periods. Occasionally the disease develops in fields where sprinkler irrigation is used or on regrowth of mint after harvest.

The anthracnose fungus overwinters mainly in old mint refuse and not in the soil. The most practical and economical method for control is to plow under the old mint in the fall. Trash shields on the plow insure that all the mint refuse is well covered. Stolons that are completely buried rarely produce infected plants, even if these stolons were from plants infected the year before. Disease-free stock should be planted in new fields. Transplants are a frequent source of anthracnose infection in the field.

If anthracnose develops late in the season, applications of fungicides will reduce spread of the disease. The local county agent or State agricultural experiment station can recommend the fungicides to use and rates of applications.

Minor Diseases

A number of minor diseases of peppermint and spearmint are sometimes troublesome. In Oregon and Washington, powdery mildew disease (caused by *Erysiphe cichoracearum*) may be damaging on both peppermint and spearmint. This disease is recognized by the conspicuous, gray-white, powdery fungus growth on the leaves. Heavily infected leaves yellow and soon drop from the plant.

Peppermint is frequently damaged by leaf blight (caused by *Cephalosporium* sp.), especially in older stands. The symptoms include large, conspicuous dark-brown to black leaf lesions that spread rapidly and cause defoliation. Infection occurs principally through wounds made by insects and machinery or other mechanical damage. Blighted leaves turn black and defoliation is heavy, especially of older leaves. Infection and disease development is favored by wet weather and rank growth.

In the Midwest, spearmint stands are usually infected with Septoria leafspot disease (caused by *Septoria menthae*). The symptoms include distinct leaf lesions with gray-white centers and dark borders. Infection begins on the lower leaves and is most prevalent in meadow mint stands. Extensive defoliation may occur in cool, wet seasons.

The dormant stolons of both peppermint and spearmint may suffer considerable loss in vigor due to infection by certain soilborne fungi. The symptoms include distinct, reddish-brown lesions that enlarge rapidly and later become soft and rotted. The problem is often associated with winter injury in the Midwest and frequently causes considerable reduction in available planting stock. The causal organism appears to be principally *Rhizoctonia* sp., although *Fusarium solani* is also associated with this infection.

In each of the diseases discussed in this section the damage caused is usually slight and seldom warrants direct control. When there is concern, the grower should consult the State agricultural experiment station or the local county agent for specific control recommendations.

Nematodes

Three different species of nematodes attack the peppermint crop in Oregon and Washington. The nematode species *Longidorus menthasolanus*, which is very slender, white, and nearly one-fourth inch in length, causes the most serious damage. Losses in individual fields range from a trace to the development of large barren areas. This species feeds on the roots of young mint plants, causing stunting and reddening of the infected plant. The roots of affected plants are usually short, bunchy, and dark.

Two other nematodes attack mint—the northern root knot nematode (*Meloidogyne hapla*) and the pin nematode (*Paratylenchus macrophallus*). Plants infested by either nematode are unthrifty and stunted and the roots may be dark. The disease caused by the root knot nematode is easily recognized by the presence of small galls or enlarged areas on the roots of infected plants. These galls contain the female nematodes and egg masses.

Unless crop rotation is practiced, nematode problems will likely increase in the Pacific Northwest. Soil fumigation is the most satisfactory method of control in areas already infested. Growers should consult the State agricultural experiment station or county agent for the latest recommendations of soil fumigants for nematode control.

INSECTS

FIGURE 7.—Mint loopers feeding on the foliage of Scotch spearmint.

Numerous insects may become troublesome on peppermint and spearmint. In the Midwest, loopers and several species of cutworms are the worst pests. In Oregon and Washington, the mint flea beetle, various root weevils, loopers, and symphylids are frequently injurious to mint.

Growers should consult the local county agent or State agricultural experiment station for recommendations of insecticides and rates of application that may be used against specific insect pests. Application of an insecticide should be made at the minimum effective dosage and as long before harvest as possible.

The loopers (mint looper *Rachiplusia ou*, celery looper *Anagrapha falcifera*, and cabbage looper *Trichoplusia ni*) are caterpillars that feed on the leaves of both peppermint and spearmint (fig. 7). Plants are often completely defoliated if these insects are present in large numbers. The loopers first appear in mid-June or July and may reappear in August and September.

Plants severely defoliated by loopers tend to grow out in 2 to 3

weeks. If cutting can be delayed in such instances the crop may recover partially. Loopers are not abundant every year; certain parasites, predators, and diseases hold them in check. When loopers are abundant and destructive, applications of insecticides control this insect.

Several species of cutworms are serious pests of mint early in the season when the new plants sprout or the new growth starts on meadow mint. Cutworms live in the loose soil and can cut off the young plants before or after they reach the surface of the soil. Other cutworms gather under accumulations of loose hay in late summer. They attack the new growth after harvest. Cutworms are controlled by application of insecticides to the soil in the spring or in the late summer after harvest.

The mint flea beetle (*Longitarsus waterhousi*) eats small holes in the leaves and sometimes causes considerable leaf fall and browning of the plants. During the hottest part of the day the beetles collect on the underside of the leaves and stems or in the shade on the ground. The larvae feed on the roots and underground stolons in the spring. They produce tunnels on the surface of the stolons and damage the lateral and feeder roots. Damaged plants become stunted and reddened. Severely damaged plants may die.

The adult flea beetles usually appear during June or July. After feeding for 3 or 4 weeks, the adult female begins to lay eggs in the soil. Egg laying continues until the beginning of cold weather.

Crop rotation or summer fallowing controls the flea beetle to some extent. Under these practices the field and surrounding area should be kept free from volunteer or wild mints, as the beetles will survive on these. However, soil treatment with insecticides is the most effective method to control the insect.

The larvae or grubs of several root weevils (*Brachyrhinus* spp.), including the black vine weevil, feed on the roots and stolons of mint, and injure and stunt the plants if the soil is heavily infested. Soil treatments with insecticides are effective.

In Oregon and Washington the garden symphilid (*Scutigerella immaculata*) is a troublesome soil pest. This tiny, white, many-legged creature lives in the soil in large numbers and feeds on the fine roots of mint and other plants. Affected plants become stunted, grow slowly or die, and the roots are severely pruned. Soil treatments are available for control of symphylans.

Several species of leafhoppers, aphids, plant bugs, and mites suck the juices from the foliage and stems of mint. Application of insecticides often is necessary for control.

HARVESTING

It is generally assumed that both quantity and quality of mint oil are highest at the flowering stage. Oil from the flowers may cause objectionable off-flavors when plants are in full bloom. This accounts in part for differences in oil quality from one growing area to another.

In the Pacific Northwest the crop is usually harvested at the full-bloom stage. In this area, the long growing season and long days with much sunshine contribute to early flowering and high oil production. In the Midwest, it may be necessary to harvest before flowering begins. In some seasons, mint, particularly meadow mint, flowers sparsely and growers must rely on experience to determine when to cut

BN–8507–X

FIGURE 8.—Mowing a field of Scotch spearmint.

the crop. Some growers run trial distillations and then apply a test for menthol that indicates the proper stage for harvesting. Details of the test may be obtained from the Purdue University Agricultural Experiment Station, Lafayette, Ind., where it was developed.

In the Midwest, mint harvest normally begins in late July and extends through August and into September, depending on the locality and weather. Meadow mint matures first and frequently a second cutting is made later, especially with the spearmints. Heavy rainfall reduces oil yields and interferes with curing in the field. A rank growth on the fertile muck soils is likely to remain damp for long periods and the plants may shed the lower leaves before the harvest stage is reached. If this occurs, the crop should be cut early.

In Oregon and Washington when a second cutting is planned, the first crop is generally cut before it reaches its best development in order to obtain a second cutting before the onset of heavy rains.

The two-crop practice is of doubtful value, unless seasonal conditions make it possible to cut both crops at the proper time. The oil obtained from too early cutting is frequently of inferior quality and is lacking in the characteristics demanded by the market.

Both row and meadow mint are harvested with sickle bar mowers. The sickle bar is fitted with a vine lifter. Row mint is cut one row at a time (fig. 8). Accordingly, the sickle bar must be shortened to cut 3-foot widths.

After the mint is cut, it should lie in the swath a day or two until it is partially cured; then it is raked into windrows with a side-delivery rake. If possible, the hay should be raked early in the morning while the mint is still tough. If the hay is too dry, it should be handled carefully, as yield may be reduced if too many leaves shatter. After the hay has dried for 2 or 3 days, it is hauled to the still.

BN—8509—X

FIGURE 9.—Chopping mint hay with a forage harvester.

Mechanical choppers are coming into general use to pick up the partially dried mint hay from the windrow and chop and blow it into wagons or portable distilling tubs (fig. 9). Mechanical choppers enable the growers to process one-fourth to one-third more mint hay per tub than when unchopped hay is used. Furthermore, if portable tubs are used, they eliminate one harvesting operation—that of transferring the hay from wagon or truck to central distilling tubs.

Many growers use hayloaders for loading the mint onto flat hayracks, usually with built-up sides. Slings, grapple forks, or harpoon forks transfer the hay to the distilling tubs and remove it after distillation.

DISTILLATION OF OIL

The process of removing oil from mint consists of passing steam through the hay, thus vaporizing the oil. The steam and oil vapors are then conducted through a condenser, and are reduced to water and oil. As they are collected in receivers, the water and oil separate into layers, with the oil floating on the surface. Although distilling equipment has gradually improved, the method for removing oil from the plant has remained unchanged (fig. 10).

Description of Stills

A distilling unit consists of a high-pressure boiler for generating steam, a tub, a condenser, and a receiver. Even in the smallest distilling units, two tubs are installed for each condenser. One tub can then be charged with mint hay while the other is in operation or is being discharged. On larger farms, four or more tubs are usually operated in pairs, with a condenser for each pair. Sometimes, a single large condenser is adequate for four tubs.

Most boilers operate at a steam pressure of 85 to 100 pounds. Friction in the line lowers the pressure delivered to the tub. A gage should

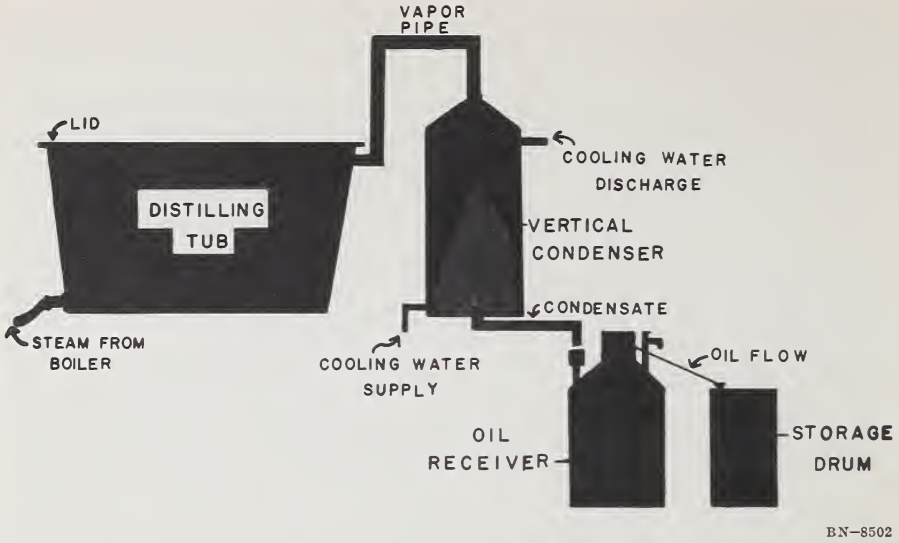


FIGURE 10.—Schematic diagram of distilling unit. The mint hay is placed in the distilling tub and heated by steam. The oil and water vapors pass from the tub to a condenser. The resulting oil and water flow to a receiver. It is separated in the receiver and the oil is drained into a storage drum.

be installed on the tub to measure the amount of pressure delivered. An ample supply of steam is necessary to distill the mint efficiently. Boilers should be large enough to deliver enough steam to process the largest amount of mint that can be handled.

All stills must be registered with the U.S. Internal Revenue Service, regardless of the purpose for which intended. Blank forms for applications can be obtained from the Director of Internal Revenue of the district in which the still is to be operated. Also, most States require periodic inspection of steam boilers of the kind used on mint farms.

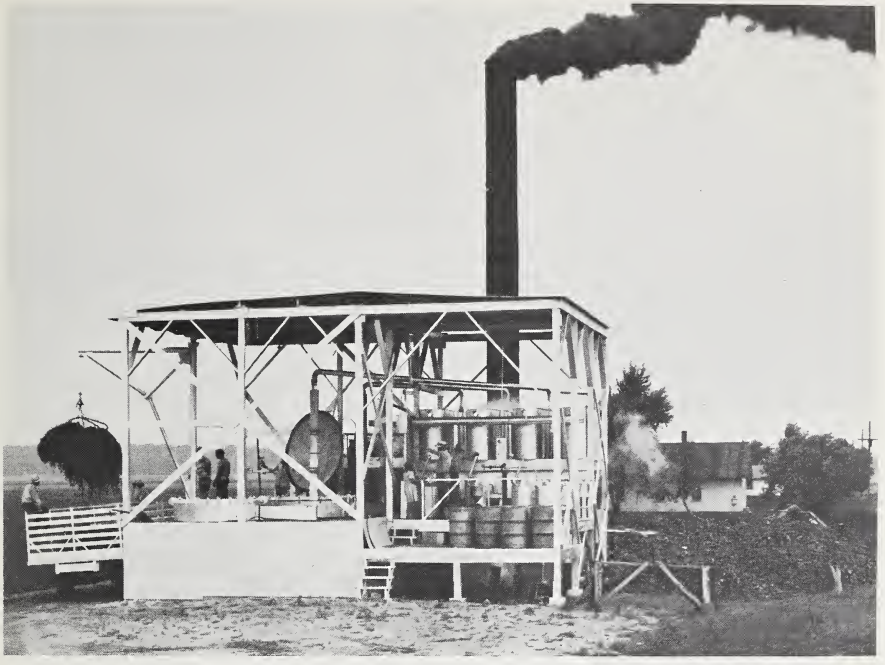
Tubs

Since it takes less time to discharge and reload a tub than to complete distillation, it is more efficient to equip each tub with its own condenser in a multitub unit. This arrangement keeps the tubs in more nearly continuous operation and eliminates the need for some heavy iron pipes and valves that sometimes discolor the oil. Such a still is shown in figure 11.

Stationary tubs are set down part way in a platform, which serves as a working floor, with the tubs projecting about 2 feet above this floor. A windlass, mounted on a crane or track, is arranged to load or discharge all tubs.

The tubs vary in size—from 6 to 9 feet deep and 6 to 7 feet in diameter. Most tubs measure 7 feet in both directions. Some tubs are slightly larger at the top than at the bottom; this shape facilitates removal of the spent herb. Most tubs are made of galvanized steel, although in the Pacific Northwest some are made of cement. A flat strip of composition material is riveted to the rim of the tub or the underedge of the cover to provide a steamtight gasket. Adjustable eccentric clamps fasten the cover (fig. 12).

A 1½-inch pipe just above the bottom of the tub admits the steam. A T with open ends permits even

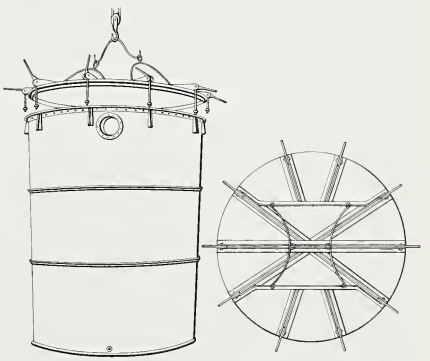


BN–8515–X

FIGURE 11.—Stationary-tub mint still, with a tank-type condenser for each tub.

distribution of steam through the charge. The outlet for the steam and oil vapors is through a pipe from the side just below the cover. This pipe has a diameter several times as large as that of the 1½-inch inlet pipe, to prevent pressure from building up in the tub. The outlet pipe usually extends upward and then passes overhead to the condenser.

Some metal tubs are fitted with an open collar around the rim about 5 inches wide and 10 inches deep. This collar holds water. The cover has a turned-down edge that fits into the collar, thus making a water seal, as mint oil is insoluble in water. The vapors leave the tub through a gooseneck from the center of the cover and are conducted to the condenser. The union of the exit pipe and condenser is also sealed with water by a similar arrangement. When the charge in the tub is exhausted, a hoist lifts the cover and swings it over for use with the other tub. No clamps are required with this type of equipment but excessive steam pressure must not be allowed to develop in the tub or the cover will be forced up and the seal broken.



BN–8505

FIGURE 12.—Galvanized-steel mint tub of the type commonly in use for distillation.

BN—8508—X

FIGURE 13.—Portable-tub mint still with a tubular condenser for each tub. The distilling tub is loaded directly in the field with chopped hay.

To reduce labor needs and increase the efficiency of distillation, many farmers are using portable tubs. Their construction is similar to that of stationary tubs, except the steam lines and condenser couplings are modified (fig. 13). The tubs are mounted on wagons or trucks and are loaded in the field with chopped hay directly from the windrow.

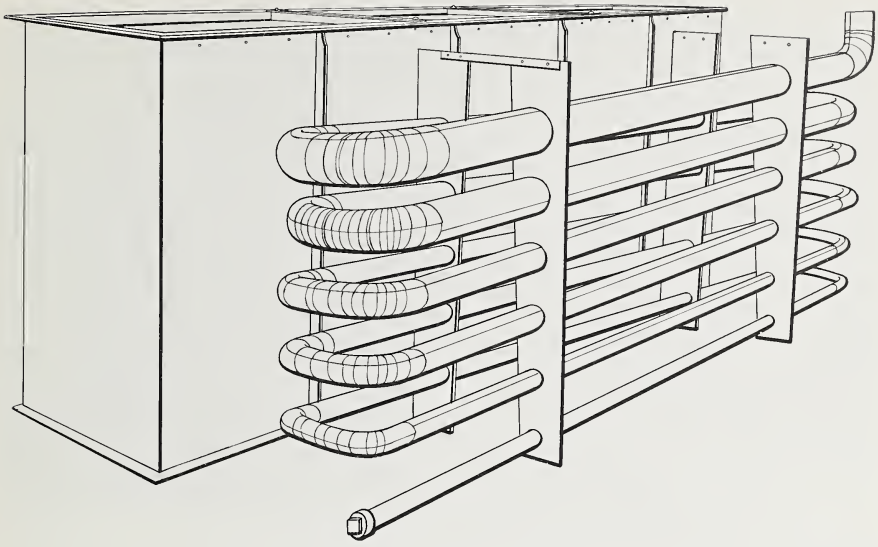
Condensers

Many condensers now in use are the tank type, or submerged condenser (fig. 14). Three to a dozen horizontal pipes are joined at the ends to form a continuous series. The first length is 7 to 8 inches in diameter and the others are reduced successively in size until the last one, from which the condensed oil and water flow, is 2 or 2½ inches in diameter. The entire worm is enclosed in a large tank. Water enters the tank continuously so that the pipes are constantly bathed in cool water.

Very few old drip-type worm condensers are still in use. In this type, the worm is exposed and is cooled by dripping water from an overhead trough.

Tubular condensers, although rather expensive, last a long time, require little space, and are very efficient (fig. 15). Numerous upright galvanized-iron pipes of small diameter are mounted in an upright galvanized-steel cylinder. As the vapors pass downward through the pipes they are condensed by cold water that circulates around the pipes. The condensed water and oil flows from a narrow outlet into the receiver.

For all condensers, aluminum or stainless steel is recommended where metal comes in contact with the oil. Thin-lined copper is less



BN–8504

FIGURE 14.—Galvanized-steel tank-type worm condenser. When in operation the condenser is inside the tank and the water temperatures are maintained at 110° F.

satisfactory, but it will give good service.

Oil Receivers

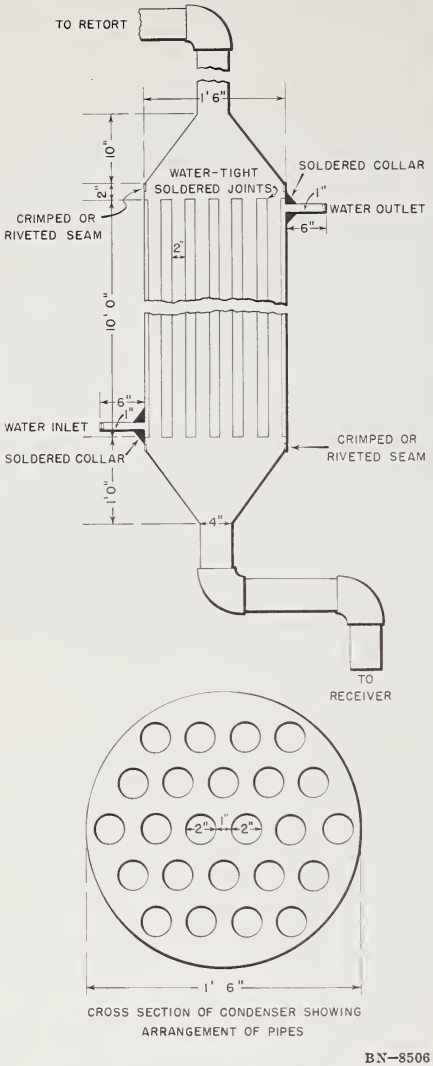
Oil receivers are simple in design and construction (fig. 16). They are cylindrical, made of galvanized iron, and vary in capacity from 10 to 50 gallons. As oil floats, the water is drawn off the bottom by a pipe that extends up along the side of the receiver to within a few inches of the top. At the top, the pipe is fitted with an elbow and a short extension pipe.

As distillation proceeds, the surface of the oil in the receiver is maintained at the desired level by raising or lowering the end of the extension pipe from which the water drains. At a point near the top of the receiver, oil is drawn off through an outlet.

Several devices are used to prevent churning of the oil in the receiver as the oil and water flow into it from the condenser. Some oil might be drawn off at the bottom with the water if too much churning occurs. In one method the flow from the condenser is directed into a funnel-topped pipe that extends about half the distance to the bottom of the receiver. The end of the pipe is fitted with a short return elbow that directs the oil toward the surface.

Another method admits the water and oil from the condenser through a pipe into the receiver. A baffle plate is installed about two-thirds the way down inside the receiver just below the pipe inlet. The baffle plate directs the separated drops of oil toward the surface.

After the hay is thoroughly heated, it is possible to economize by reducing the steam pressure as it enters the tub. Distilling efficiency will not be reduced and considerable savings in steam and fuel are possible. If the herb is well cured, it will probably require from 45 minutes to 1 hour of steaming to



BN-8506

FIGURE 15.—Details of a tubular condenser.

exhaust the charge. During this time, the second tub is emptied and reloaded (fig. 17).

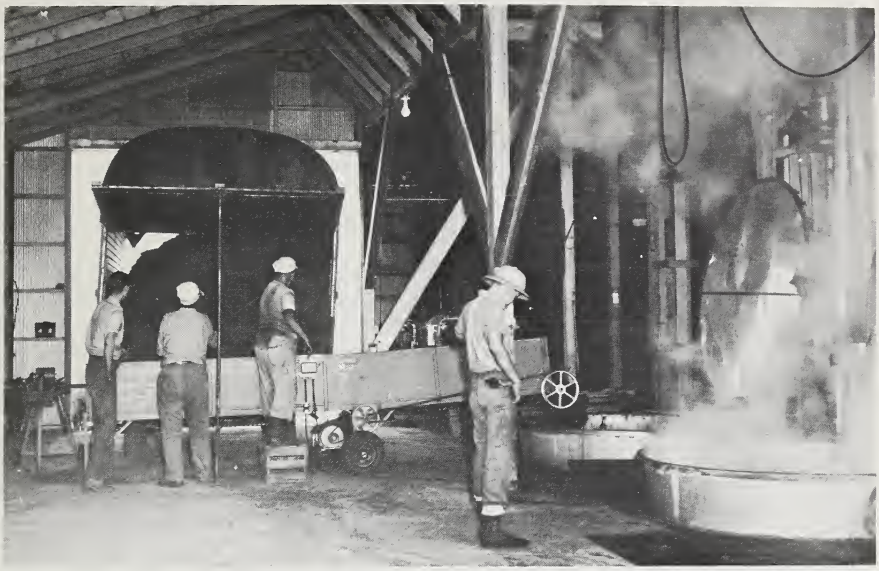
Spent hay, if properly dried, makes excellent fodder. It is relished by all kinds of livestock and is reported to equal timothy hay in feeding value.

Spent hay is also used as a fertilizer. When it is intended for this purpose, the hay is spread on the field and plowed under in the fall. Some growers deposit the refuse in large dumps and allow it to decompose before it is spread on the field. However, returning the spent hay to the field is a questionable practice, as the organism that causes Verticillium wilt finds this material a suitable growth medium.

As a rule the oil separates readily from the water in the receiver and is entirely clear if it is carefully removed. Some growers filter the oil before storing it, but this is not usually necessary. It is stored in 5- to 10-gallon galvanized drums or aluminum kegs.

BN-8512-X

FIGURE 16.—Removing peppermint oil from the receiver. The operator has brought the oil level up to the discharge spout by raising the extension pipe of the water outlet.



BN—8510—X

FIGURE 17.—Loading a stationary-tub conveyor with field-chopped hay preparatory to distilling.

Operation of Stills

When a tub is charged, the herb is packed down thoroughly so that the steam will pass uniformly through the hay instead of channeling, as is likely to occur in loosely or unevenly packed material. An iron ring or a crosspiece with chains attached is placed on the bottom of the tub. When the tub is half full, the chains are laid across the charge and the steam is turned partly on. A second ring is placed on the herb and the loading of the tub is completed. After the distillation is completed, a crane can empty the tub in two batches by means of the rings and chains. The slow admission of steam, while loading is in progress, makes it possible to pack the herb more firmly.

The cover is then clamped down and more steam is turned on. When the condensed vapors of steam and oil begin to flow from the condenser, the admission of steam is adjusted so that condensation is complete, with no loss of oil vapors. The water bath in the condenser is maintained at 110° F. for rapid separation of the oil. This temperature also holds evaporation losses to a minimum.

The time required to exhaust a charge depends on the quantity of steam admitted and the condition of the herb. It takes less time if the herb is dry. Steam coming in contact with green herb is partly condensed and much more time is required to complete the operation.

A second distillation is not generally required unless the oil is intended for use where only rectified oils are permitted or unless the oil is highly colored or of unusual composition. If the fields were kept free from weeds and the distillation was carefully conducted, the oil obtained is generally acceptable to the trade.

Both peppermint and spearmint oils may be kept for an indefinite

period without material change in the quality if the moisture is removed and the oil is stored in a cool place in completely filled clean tin cans or drums with tight closures.

ECONOMIC FACTORS IN MINT FARMING

Yield of Oil

The yield of oil from mints varies greatly with season, cultural conditions, and geographic location. Table 1 (page 4) shows the average yields in the principal mint-growing States for the period 1950–61.

First-year mint usually outyields meadow mint by about 10 pounds per acre and is less subject to disease.

Yields are reduced greatly if the plants are too thick in the field. Thick stands prevent full leaf development and cause lower leaves to fall off, owing to the continued dampness and shading. Rough handling when the herb is too dry also causes loss through shattering of leaves.

Clear, sunny weather during the few weeks preceding the harvest causes the herb to develop more oil than it will in cloudy, wet weather. Often, heavy rains at harvesttime wash off considerable amounts of oil.

Price of Oil

Prices received by farmers for peppermint and spearmint oils depend on demand, quality, and carryover from previous crops. Recent average prices are given in table 2.

TABLE 2.—*Average price per pound of mint oils received by farmers in the principal producing States, 1950–61*

Mint oil and State	Average price per pound of oil		
	1950–59	1960	1961
Peppermint Oil			
Indiana	$6.02	$5.90	$6.50
Michigan	5.98	5.60	6.40
Wisconsin	5.99	5.80	6.50
Oregon	5.10	5.00	5.50
Washington	4.14	3.80	3.05
Spearmint Oil			
Indiana	4.71	5.20	5.00
Michigan	4.69	4.90	4.80
Washington	4.05	3.50	3.30

Capital Investment and Production Costs

The equipment and machinery to grow the crop and to distill mint are expensive. The distilling operation, especially, requires equip-

ment that has no other use on the farm. It is a good idea for new growers to have their first crop or two distilled by established local operators.

Cost of equipment for distillation varies considerably, depending on location and whether equipment is purchased new or secondhand. The boiler is the most expensive item and can sometimes be bought secondhand at a considerable saving.

New equipment for a typical stationary two-tub still costs $5,500 to $6,500 at 1962 prices, and larger units cost $2,700 to $3,300 per additional tub. Larger stills are expensive, because the multitub unit requires a correspondingly larger boiler. However, the boiler should be large enough for any anticipated expansion in production. The materials used in constructing the tubs, condensers, and separators also vary the costs of a still—aluminum and stainless steel are more expensive than galvanized steel.

Production costs vary greatly among farms, but labor is the greatest single factor. In an Indiana study for 1961, the average total cost of producing oil from first-year peppermint ranged from $175 to $225 per acre. This cost included land, stolons for planting, fertilizer, pesticides, and all labor and equipment costs required to plant, cultivate, weed, harvest, and distill the crop.

Approximately 60 man-hours of labor are required per acre for the first-year crop, which represents about 30 percent of the total cost. Labor cost is less in subsequent years and averages about 25 percent of the total cost. The costs for the Indiana study are approximately as follows:

	Cost per acre
Labor and machinery	$90 to $100
Land and improvements	25 to 30
Fertilizer	30 to 40
Stolons or plants	15 to 20
Chemicals	10 to 12
Miscellaneous overhead	6 to 10
Total cost per acre	176 to 212

Weeding requires 50 percent of all the labor needed. The cost of weeding is less for first-year mint than for row mint in the following years or for meadow mint.

In dry seasons, supplemental sprinkler irrigation in Indiana, which is used to increase mint production, costs approximately $5 per acre-inch of water applied (1961 rate).

Similar studies in the irrigated areas of Oregon and Washington show the first-year's production costs total $275 to $300 an acre, and $215 to $240 for subsequent years. These estimates are based on production goals of 80 to 100 pounds of oil per acre. The first year, with an 80-pound-per-acre yield, a selling price of $4.25 per pound would be needed to give growers a return on all costs, including interest on investment, for establishment of crop, fertilizer, irrigation, distillation, harvesting, labor, supplies, depreciation, insurance, and return to management. The Oregon and Washington studies indicated that management should have a $50 to $75 an acre return to make mint growing a sound venture.

U.S. GOVERNMENT PRINTING OFFICE: 1963 O—660223